Chapter 3: Conveyance BMPs

BMP 301: Interceptor Dike and Swale

Purpose

Provide a ridge of compacted soil, or a ridge with an upslope swale, at the top or base of a disturbed slope or along the perimeter of a disturbed construction area to convey stormwater. Use the dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent storm runoff from entering the work area or sediment-laden runoff from leaving the construction site.

Conditions of Use

- Locate upslope of a construction site to prevent runoff from entering disturbed area.
- Locate where the runoff from the site or disturbed slope can be safely conveyed to an erosion control facility.
- When placed horizontally across a disturbed slope, it reduces the amount and velocity of runoff flowing down the slope.
- Locate downslope to collect runoff from a disturbed area and direct it to a sediment basin.

Design and Installation Specifications

- Dike and/or swale and channel must be stabilized with temporary or permanent vegetation or other channel protection during construction.
- Channel requires a positive grade for drainage; steeper grades require channel protection and check dams.
- Can be used at top of new fill before vegetation is established.
- May be used as a permanent diversion channel to carry the runoff.
- Sub-basin tributary area should be one acre or less.
- Design capacity for the peak flow from a 10-year, 24-hour design storm for temporary facilities. For facilities that will also serve on a permanent basis, consult the local government's drainage requirements.
- The maximum velocity should not exceed 5 fps.

Table 7: Interceptor Dike Criteria

Top Width: 2'-0" minimum
Height: 18" minimum on berm
Side Slope: 2:1 for temporary dikes; should be flatter for permanent ones
Grade: Depends on topography; system minimum is 0.5% and maximum is 1%
Compaction: min. 90% ASTM D698 standard proctor
Horizontal Spacing of Interceptor Dikes:

Average Slope	% Slope	Length of Flow
less than 20:1	3% - 5%	300 feet
10 to 20:1	5% -10%	200 feet
4 to 10:1	10% -25%	100 feet
2 to 4:1	25% -50%	50 feet

Stabilization: Depends on velocity and reach
Slopes flatter than 5%: Seed and mulch applied within 5 days (see BMP 221, Mulching).
Slopes 5% - 40%: Dependent on runoff velocities and dike materials; **stabilization should be done immediately using sod, native stone, or other measures to avoid erosion.**

Table 8: Interceptor swale criteria

Bottom Width: 24" minimum; the bottom shall be level
Depth: 12" minimum
Side Slope: 2:1 for temporary dikes; should be flatter for permanent ones
Grade Maximum: 5%, with positive drainage to a suitable outlet (such as a sediment pond)
Stabilization: Seed as per BMP 220 (Temporary and Permanent Seeding) or BMP 302 (Channel Lining); 12" thick stone pressed into the bank and extending at least 8" vertical from the bottom

Maintenance Standards

- Inspect diversion dikes and interceptor swales per the site SWPPP. Immediately remove sediment from the flow area.
- Damage caused by construction traffic or other activity must be repaired before the end of each working day.
- Check outlets and make timely repairs as needed to avoid rill and/or gully formation. When the area below the temporary diversion dike is permanently stabilized, remove the dike and fill and stabilize the channel to blend with the natural surface.
- The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping facility.
- Minimize construction traffic over temporary dikes. Use temporary cross culverts for channel crossing.
- Excessive flow rates can cause scour so they should discharge into a sediment-treatment facility.
- Energy dissipaters may be required above and/or below the outfall.

BMP 302: Grass-Lined Channels

Purpose

Provide a channel with a vegetative lining for conveyance of runoff. See the figures on the next page for typical grass-lined channel cross-sections.

Conditions of Use

This practice applies to construction sites where concentrated runoff needs to be contained to prevent erosion or flooding.

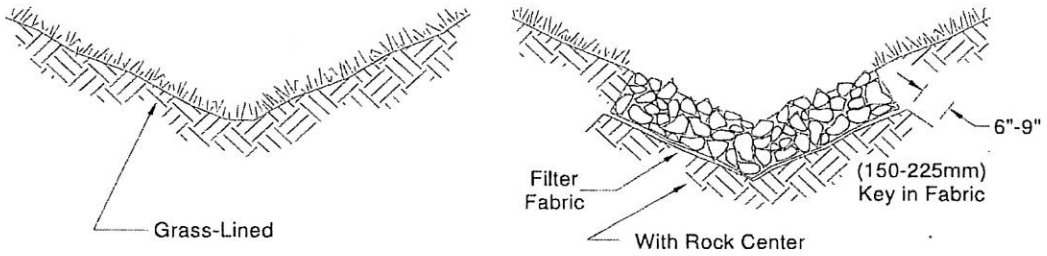
- Vegetative lining can provide sufficient stability for the channel cross section and at lower velocities of water (normally dependent on grade). This means that the channel slopes are generally flatter than 5% and space is available for a relatively large cross section.
- Typical uses include roadside ditches, channels at property boundaries, outlets for diversions, and other channels and drainage ditches in low areas.
- Channels that will be vegetated should be installed before major earthwork and hydro-seeded with a BFM. The vegetation should be well established (i.e., over 75% cover) before water is allowed to flow in the ditch. With channels that will have high flows, erosion control blankets should be installed over the hydro-seed. If vegetation cannot be established from seed before water is allowed in the ditch, sod should be installed in the bottom of the ditch in lieu of hydro-mulch and blankets.

Design and Installation Specifications

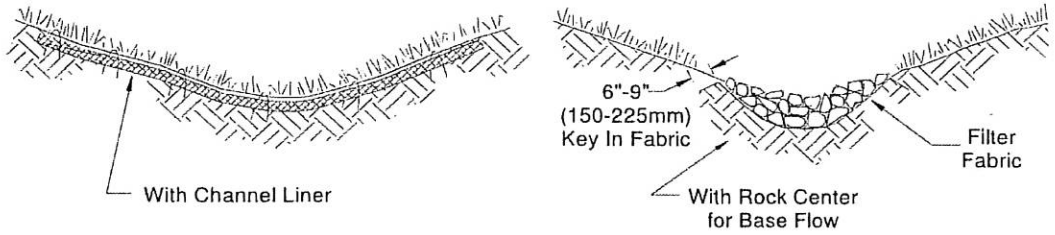
- Locate the channel where it can conform to the topography and other features such as roads.
- Locate them to use natural drainage systems to the greatest extent possible.
- Avoid sharp changes in alignment or bends and changes in grade.

- Do not reshape the landscape to fit the drainage channel.
- Design velocities exceeding 2 fps require temporary blankets, mats, or similar liners to protect seed and soil until vegetation becomes established.

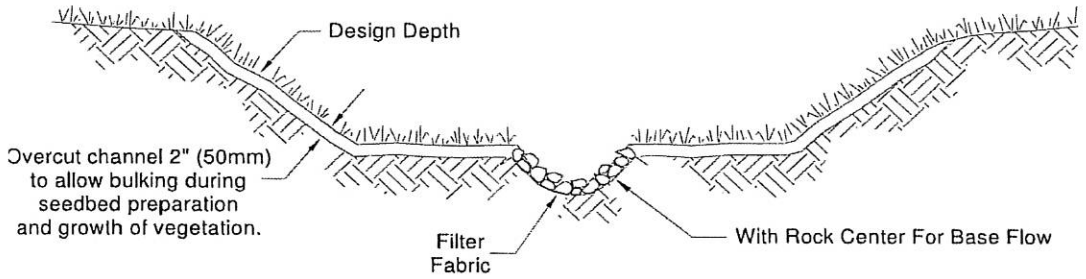
Typical V-Shaped Channel Cross-section



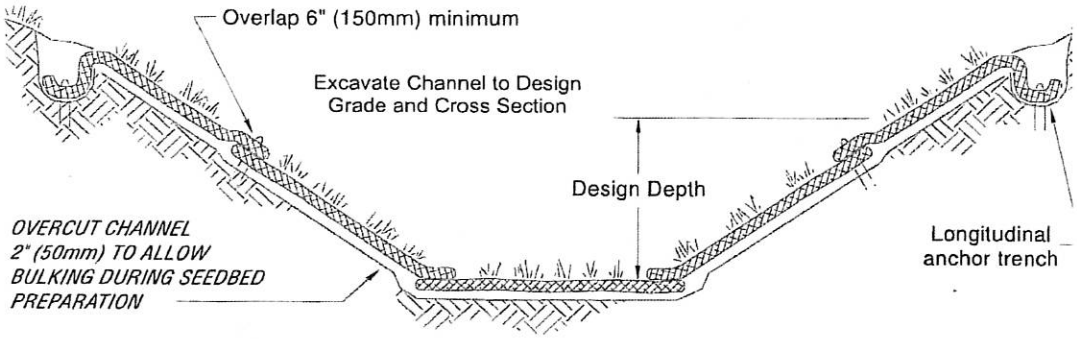
Typical Parabolic Channel Cross-Section

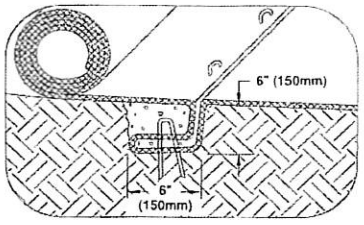


Typical Trapezoidal Channel Cross-Section



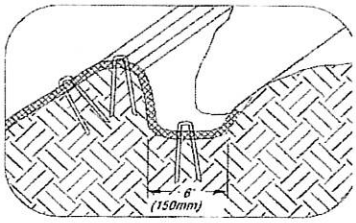
- The maximum design velocity shall be based on soil conditions, type of vegetation, and method of re-vegetation, but at no times shall velocity exceed 5 fps without additional reinforcing of the channel bottom. The channel shall not be overtopped by the peak runoff from a 10-year, 24-hour design storm.
- Where the grass-lined channel will also function as a permanent stormwater conveyance facility, consult the drainage conveyance requirements of the local jurisdiction.
- An **established** grass or vegetated lining is required before the channel can be used to convey stormwater, unless stabilized with nets and/or blankets.
- If design velocity of a channel to be vegetated by seeding is higher than 2 fps, a temporary channel liner is required. Geo-textile or special mulch protection such as fiberglass, straw, and/or netting provides stability until the vegetation is fully established. See the figure on the next page.



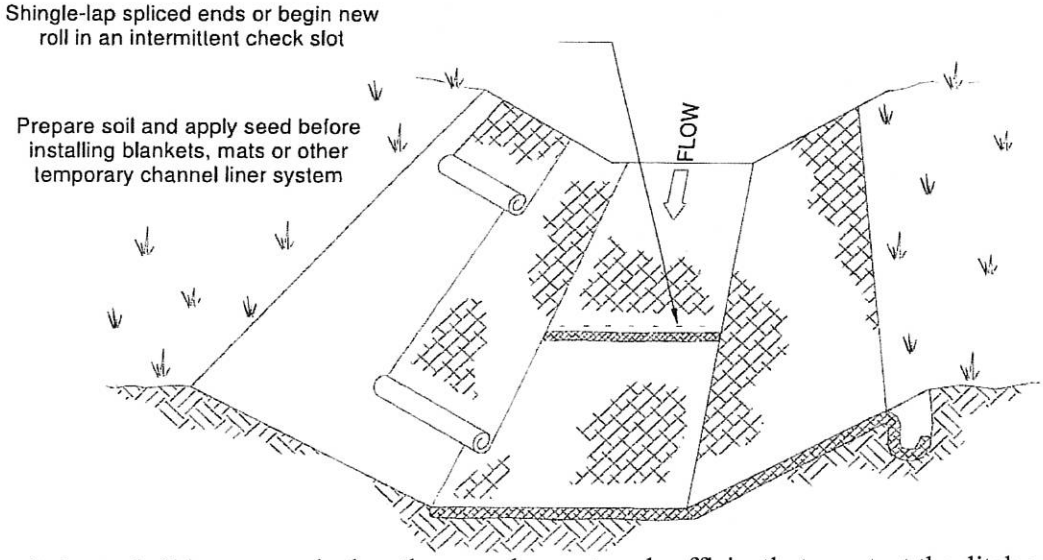


Intermittent Check Slot

TYPICAL INSTALLATION WITH EROSION CONTROL BLANKETS OR TURF REINFORCEMENT MATS



Longitudinal Anchor Trench



- Check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale, unless the slope of the swale is over 4%. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- Watering may be required.
- If vegetation is established by sodding, the permissible velocity for established vegetation must be used so that no temporary liner is required.
- Do not subject grass-lined channel to sedimentation from disturbed areas. Use sediment-trapping BMPs upstream of the channel.
- Subsurface drainage or stone channel bottoms, if allowed, may be necessary on sites that are subject to prolonged wet conditions due to long duration flows or a high water table.
- Provide outlet protection at culvert ends and at channel intersections.
- Grass channels, at a minimum, should carry peak runoff for temporary construction drainage facilities from the 10-year, 24-hour storm without eroding. Where flood hazard exists, increase the capacity according to the potential damage.
- Grassed channel side slopes generally are constructed 3:1 or flatter to aid in the establishment of vegetation and for maintenance. Consult local drainage requirements or development codes for

permanent channels.
- Construct channels a minimum of 2" larger around the periphery to allow for soil bulking during seedbed preparations and sod buildup.

V-shaped grass channels generally apply where the quantity of water is small, such as in short reaches along roadsides. The V-shaped cross section is least desirable because it is difficult to stabilize the bottom where velocities may be high.

Trapezoidal grass channels are used where runoff volumes are large and slope is low so that velocities are non-erosive to vegetated linings. (**Note**: It is difficult to construct small parabolic shaped channels.)

Maintenance Standards

During the establishment period, check grass-lined channels after every rainfall.
- After grass is established, periodically check the channel; check it after every heavy rainfall event or construction site SWP3 requirements. Immediately make repairs.
- It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes.
- Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times, since it is the primary erosion protection for the channel.

BMP 303: Reinforced Channel Lining

Purpose

To protect erodible channels by providing a channel liner using either blankets or stone.

Conditions of Use

When natural soils or vegetated stabilized soils in a channel are not adequate to prevent channel erosion.
- When a permanent ditch or pipe system is to be installed and a temporary measure is needed.
- In almost all cases, synthetic and organic coconut blankets are more effective than native stone for protecting channels from erosion. Blankets can be used with and without vegetation. Blanketed channels can be designed to handle any expected flow and longevity requirement. Some synthetic blankets have a predicted life span of 50 years or more, even in sunlight.
- Other reasons why blankets are better than stone include the availability of blankets over rock. In many areas, rock may not be easily obtainable, is very expensive to haul to a site, and/or may be prohibited to use by local ordinance. Blankets can be delivered anywhere. Rock requires the use of heavy equipment to haul and place. Blankets usually only require laborers with hand tools, and sometimes a backhoe.
- The Federal Highway Administration (FHA) recommends not using flexible liners whenever the slope is above 10%, or the shear stress is greater than 8 psf.

Design and Installation Specifications

See BMP 222 for information on nets and blankets. Since stone is used where erosion potential is high, construction must be sequenced so that the stone is put in place with the minimum possible delay.
- Disturbance of areas where the stone is to be placed should be undertaken only when final preparation and placement of the stone can follow immediately behind the initial disturbance. Where stone is used for outlet protection, it should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.
- The designer, after determining the stone size that will be stable under the flow conditions, shall consider that size to be a **minimum** size and then, based on gradations available in the area, select the size(s) that equal or exceed the minimum size. The possibility of drainage structure damage by

children shall be considered in selecting a stone size, especially if there is nearby water or a gully in which to toss the stones.

- Stone shall consist of field stone or quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all respects for the purpose intended.
- Rubble concrete may be used provided it has a density of at least 150 pcf and otherwise meets the requirement of this standard and specification.
- A lining of engineering filter fabric (geo-textile) shall be placed between the stone and the underlying soil surface to prevent soil movement into or through the stone. The geo-textile should be keyed in at the top of the bank.
- Filter fabric shall not be used on slopes greater than 3:2 as slippage may occur. It should be used in conjunction with a layer of coarse aggregate (granular filter blanket) when the stone to be placed is 12" and larger.

Maintenance Standards

BMP 304: Vegetated Strip

Purpose

Vegetated strips reduce the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

Conditions of Use

- Vegetated strips may be used downslope of all disturbed areas.
- Vegetated strips are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstances in which overland flow can be treated solely by a strip, rather than by a sediment pond, is when the criteria in the following table are met, or municipal specifications, whichever is more restrictive.

Table 9: Vegetated Strip

Average Slope	% Slope	Length of Flow
3:2 or less	less than 67%	100 feet
2:1 or less	less than 50%	115 feet
4:1 or less	less than 25%	150 feet
6:1 or less	less than 16%	200 feet
10:1 or less	less than 10%	250 feet

Design and Installation Specifications

- The vegetated strip shall consist of a minimum of a 25'-0" wide continuous strip of dense vegetation with permeable topsoil. Grass covered, landscaped areas are generally not adequate because the volume of sediment overwhelms the grass. Ideally, vegetated strips shall consist of undisturbed native growth with a well-developed soil that allows for infiltration of runoff.
- The slope within the strip shall not exceed 4:1.
- The uphill boundary of the vegetated strip shall be delineated with clearing limits.

Maintenance Standards

- Any areas damaged by erosion or construction activity shall be seeded immediately and protected by mulch.

- If more than 5'-0" of the original vegetated strip width has had vegetation removed or is being eroded, sod must be installed.
- If there are indications that concentrated flows are traveling across the buffer, surface water controls must be installed to reduce the flows entering the buffer, or additional perimeter protection must be installed.

BMP 310: Diversionary Ditch

Purpose

A small ditch or ridge of material is constructed diagonally across a road or right-of-way to divert stormwater runoff from the road surface, wheel tracks, or a shallow road ditch.

Conditions of use

Clearing right-of-way and construction of access for power lines, pipelines, and other similar installations often require long narrow right-of-ways over sloping terrain. Disturbance and compaction promotes gully formation in these cleared strips by increasing the volume and velocity of runoff. Gully formation may be especially severe in tire tracks and ruts. To prevent the formation of rills and gullies, runoff can often be diverted across the width of the right-of-way to undisturbed areas by using small pre-designed diversions.

Give special consideration to each individual outlet area, as well as to the cumulative effect of added diversions. Use gravel to stabilize the diversion where significant vehicular traffic is anticipated.

Design and Installation Specifications

- Height: 8" minimum measured from the channel bottom to the ridge top
- Side slope of channel: 2:1 maximum; 3:1 or flatter when vehicles will cross.
- Base width of ridge: 6" minimum.
- Locate to use natural drainage systems and to discharge into stable, well-vegetated areas.

Table 10: Diversionary Ditch Spacing Guidelines

% Slope	Spacing
Less than 5%	125 feet
5% to 10%	100 feet
10% to 20%	75 feet
20% to 35%	50 feet
More than 35% use rock lining	

- Grade and angle: Select angle that results in ditch slope less than 2%.
- Install as soon as the clearing and grading is complete. Reconstruct when construction is complete on a section when utilities are being installed.
- Compact the ridge when installed.
- Stabilize; seed; and mulch the portions that are not subject to traffic. Gravel the areas crossed by vehicles.

Maintenance Standards

- Periodically inspect right-of-way diversions for wear and after every heavy rainfall for erosion damage.
- Immediately remove sediment from the flow area and repair the dike.
- Check outlet areas and make timely repairs as needed.
- When permanent road drainage is established and the area above the temporary right-of-way

diversion is permanently stabilized, remove the dike and fill the channel to blend with the natural ground, and appropriately stabilize the disturbed area.

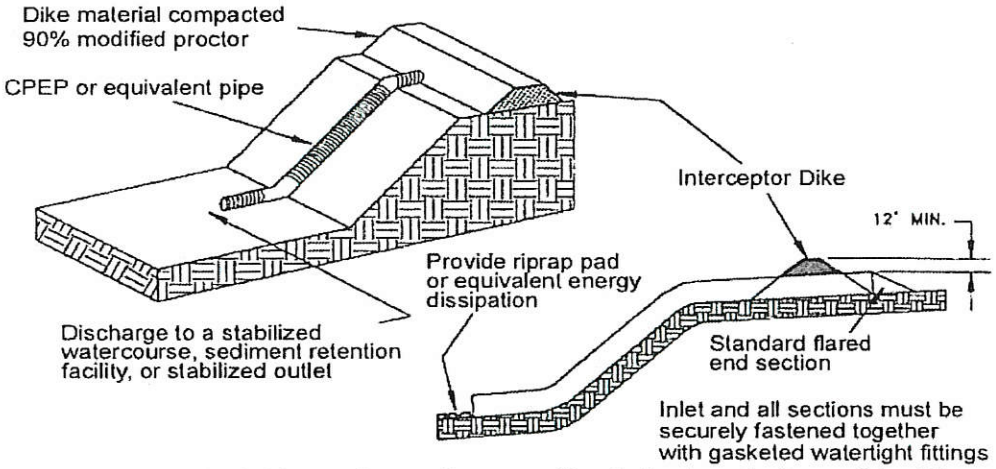
BMP 311: Pipe-Slope Drains

Purpose

To convey stormwater any time water needs to be diverted away from or over bare soil to prevent gullies, channel erosion, saturation of slide-prone soils, or the creation of concentrated flows.

Conditions of Use

Pipe-slope drains can be open or closed conduits used as a temporary or permanent stormwater conveyance to move the water down a steep slope to protect the slope from erosion. See the figure below.



On highway projects, they should be used at bridge ends to collect runoff and pipe it to the base of the fill slopes along bridge approaches. These can be designed into a project and included as bid items. Another use on road projects is to collect runoff from pavement and pipe it away from side slopes. These are useful because there is generally a time lag between having the first lift of asphalt installed and the curbs, gutters, and permanent drainage installed. Used in conjunction with sand bags, or other temporary diversion devices, these will prevent massive amounts of sediment from leaving a project.

Water can be collected; channeled with: sand bags, Geo-textile Encased Check Dams (BMP 308), berms, or other material; and/or piped to temporary sediment ponds.

Pipe-slope drains can be:

- Connected to new catch basins and used temporarily until all permanent piping is installed;
- Used to drain water collected from aquifers exposed on cut slopes and take it to the base of the slope;
- Used to collect clean runoff from plastic sheeting and direct it away from exposed soil;
- Installed in conjunction with BMP 351 (Reinforced Perimeter Sediment Barrier) to drain collected water to a controlled area;
- Used to divert small seasonal streams away from construction. They have been used successfully on culvert replacement and extension jobs. Large flex pipe can be used on larger streams during culvert removal, repair, or replacement; and,
- Connected to existing down spouts and roof drains and used to divert water away from work areas during building renovation, demolition, and construction projects. There are now several commercially available collectors that are attached to the pipe inlet and help prevent erosion at the inlet.

Design and Installation Specifications

Size to convey the design flow. The capacity for temporary drains shall be sufficient to handle the peak flow from a 10-year, 24-hour design storm event. Consult local drainage requirements for sizing permanent pipe-slope drains.

- Water should be collected from an area smaller than 5 acres in size.
- Most jurisdictions have a minimum pipe size requirement.
- Open conveyances should have higher sides to ensure that all flows are contained.
- Energy dissipaters may be required before the outfall.
- Use care in clearing vegetated slopes for installation.
- Re-establish cover immediately on areas disturbed by installation.
- Use temporary drains on new cut or fill slopes.
- Use diversion dikes or swales to collect water at the top of the slope. Ensure that the inlet area is stable and large enough to direct flow into the pipe.
- Piping of water through the berm at the site's entrance area is a common failure mode.
- The inlet side shall consist of a standard flared end section for culverts 12" and larger with a minimum 6" metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance shall be steeper than 3%. Sand bags may also be used at pipe inlets as a temporary measure.
- The soil around and under the pipe and entrance section shall be thoroughly compacted to prevent undercutting.
- The flared inlet sections should be securely connected to the slope drain with watertight connecting bands.
- Slope drain sections should be securely fastened together, fused or have gasketed watertight fittings, and be anchored into the soil.
- Thrust blocks should be installed at each 90-degree pipe bends are utilized. Depending on size of pipe and flow, these can be constructed with sand bags, straw bales staked in place, T-posts and wire, or ecology blocks.
- Pipes need to be secured along their length to prevent movement every 10 to 20 feet of pipe length, depending on the size of the pipe and quantity of water to be diverted. Anchoring can be done with steel T-posts and wire by installed a post on each side of the pipe and then wiring the pipe to them.
- Interceptor dikes shall be used to direct runoff into a slope drain. The height of the dike shall be at least 12" higher at all points than the top of the inlet pipe.
- The area below the outlet must be stabilized (see BMP 340 Outlet Protection) with a stone apron or other appropriate outlet material.
- If the pipe-lope drain conveys sediment-laden water, all flows needs to be directed into a sediment-trapping facility or device.
- Material specifications for many pipe systems are set by the local jurisdiction.
- Incorrect construction may lead to the gullies, rills, erosion, scour, and/or the failure of other downstream devices.

Maintenance Standards

Check inlet and outlet points regularly, especially after storms.

- The inlet should be free from undercutting, and no water should be going around the point of entry. If there are problems, a headwall may need to be constructed or shall be reinforced with compacted earth or sand bags.
- The outlet point should be free from erosion and installed with appropriate outlet protection (i.e. energy dissipater and/or scour prevention).
- For permanent installations, inspect the pipe periodically for vandalism and physical distress such as slides and wind-throw.
- Normally the pipe slope is so steep that clogging is not a problem with a smooth-wall pipe; however, trash and/or debris may become lodged in the pipe.

BMP 312: Subsurface Drains

Purpose

To intercept, collect, and convey ground water to a satisfactory outlet, using a perforated pipe or conduit below the ground surface. Subsurface drains are also known as French drains. The perforated pipe provides a dewatering mechanism to drain excessively wet soils, provide a stable base for construction, improve stability of structures with shallow foundations, and/or to reduce hydrostatic pressure to improve slope stability.

Conditions of Use

Use when excessive water must be removed from the soil. The permeability of the soil as well as the depth to water table and impervious layers are all factors which govern the use of subsurface drains.

This standard does not apply to subsurface drains for building foundations or deep excavations.

Design and Installation Specifications

Relief drains are used either to lower the water table in large, relatively flat areas; improve the growth of vegetation; and/or to remove surface water. They are installed along a slope and drain in the direction of the slope. They can be installed in a grid pattern; a herringbone pattern; or a random pattern.

Interceptor drains are used to remove excess groundwater from a slope; stabilize steep slopes; and/or lower the water table immediately below a slope to prevent the soil from becoming saturated. They are installed perpendicular to a slope and drain to the side of the slope. They usually consist of a single pipe or series of single pipes instead of a patterned layout.

- The **depth and spacing of an interceptor drain** is determined primarily by the depth to which the water table is to be lowered or the depth to a confining layer. For practical reasons, the maximum depth is usually limited to 6'-0", with a minimum cover of 24" to protect the conduit.
- The soil should have depth and sufficient permeability to permit installation of an effective drainage system at a depth of 24" to 6'-0".
- An adequate outlet for the drainage system must be available either by gravity or by pumping.
- The quantity and quality of discharge needs to be accounted for in the receiving stream (additional detention may be required).
- The capacity of an interceptor drain is determined by calculating the maximum rate of ground water flow to be intercepted. Therefore, it is good practice to make complete subsurface investigations, including hydraulic conductivity of the soil, before designing a subsurface drainage system.
- **Subsurface drains should be sized** to carry the required capacity without pressure flow. Minimum diameter for a subsurface drain is 4".
- The minimum velocity required to prevent silting is 1.4 fps. The line shall be graded to achieve this velocity at a minimum. The maximum allowable velocity using a sand-gravel filter or envelope is 9 fps.
- Filter material and fabric shall be used around all drains for proper bedding and filtration of fine materials. Envelopes and filters should surround the drain to a minimum of 3" thickness.
- The outlet of the subsurface drain shall empty into a sediment pond through a catch basin. If free of sediment, it can then empty into a receiving channel, swale, or stable vegetated area adequately protected from erosion and undermining.
- The trench shall be constructed on a continuous grade with no reverse grades or low spots.
- Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material.
- Backfilling shall be done immediately after placement of the pipe. No sections of pipe shall remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drain pipe is not displaced or damaged. Do not install permanent drains near trees. Avoiding the tree roots will prevent them from expanding towards the line and clogging it. Use solid pipe with watertight connections where it is necessary to pass a subsurface drainage system through a stand of trees (whether existing or to be placed at a later date).

- Ensure that the **outlet** of a drain empties into a channel or other watercourse above the normal water level.
- Secure an animal guard to the outlet end of the pipe to keep out rodents.
- Use outlet pipe of corrugated metal, cast iron, or heavy- duty plastic without perforations and at least 10'-0" long. Do **not** use an envelope or filter material around the outlet pipe. Bury at least two-thirds of the pipe length.
- When outlet velocities exceed those allowable for the receiving stream, outlet protection must be provided.

Maintenance Standards

Subsurface drains shall be checked periodically to ensure that they are free-flowing and not clogged with sediment or roots.

- The outlet shall be kept clean and free of debris.
- Surface inlets shall be kept open and free of sediment and other debris.
- Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain or remove the trees as a last resort. Drain placement should be planned to minimize this problem.
- Where drains are crossed by heavy vehicles, the line shall be checked to ensure that it is not crushed.

BMP 313: Level Spreader

Purpose

Level spreaders provide a temporary outlet for dikes and diversions consisting of an excavated depression constructed at 0% grade across a slope, or can convert concentrated runoff to sheet flow and release it onto areas stabilized by existing vegetation or an engineered filter strip.

Conditions of Use

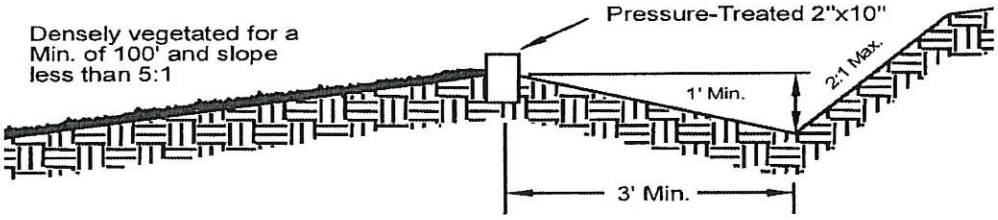
Used when a concentrated flow of water needs to be dispersed over a large area with existing stable vegetation.

- Use only where the slopes are gentle, the water volume is relatively low, and the soil will absorb most of the low flow events.
- Items to consider are:
  1. What is the risk of erosion or damage if the flow may become concentrated?
  2. Is an easement required if discharged to adjoining property?
  3. Most of the flow should be as ground water and not as surface flow.
  4. Is there an unstable area downstream that cannot accept additional ground water?

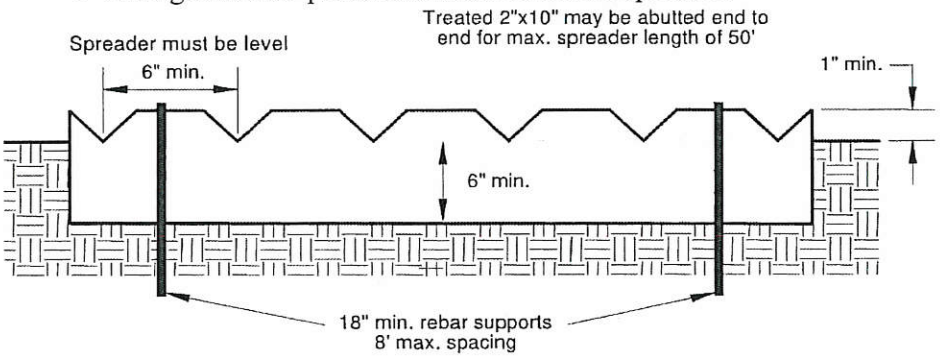
Design and Installation Specifications

- Use above undisturbed areas that are stabilized by existing vegetation. If the level spreader has any low points, flow will concentrate, create channels and may cause erosion.
- Discharge area below the outlet must be uniform with a slope of less than 5:1.
- Outlet to be constructed level in a stable, undisturbed soil profile (not on fill).
- The runoff shall not be allowed to re-concentrate after release unless intercepted by another downstream measure.
- The grade of the channel for the last 20'-0" of the dike or interceptor entering the level spreader shall be less than 1%. The grade of the level spreader shall be 0% to ensure uniform spreading of storm runoff.
- A 6" high gravel berm placed across the level lip shall consist of washed crushed rock, ¾" to 1½" OR 2" to 4" in size.

- The spreader length shall be determined by estimating the peak flow expected from the 10-year, 24-hour design storm. The length of the spreader shall be a minimum of 15'-0" for 0.1 cfs and shall be an additional 10'-0" for each 0.1 cfs there after to a maximum of 0.5 cfs per spreader. Use multiple spreaders for higher flows.
- The width of the spreader should be at least 6'-0".
- The depth of the spreader as measured from the lip should be at least 6" and uniform across the entire length.
- Level spreaders shall be setback from property lines unless there is an easement for the flow.
- Level spreaders, when installed every so often in grassy swales, keep flows from re-concentrating. Materials that can be used include sand bags, logs, lumber, concrete, and pipes. To function properly, the materials need to be installed level and on-contour. The figure below provides a cross-section of a level spreader.



- The figure below provides a detail of a level spreader.



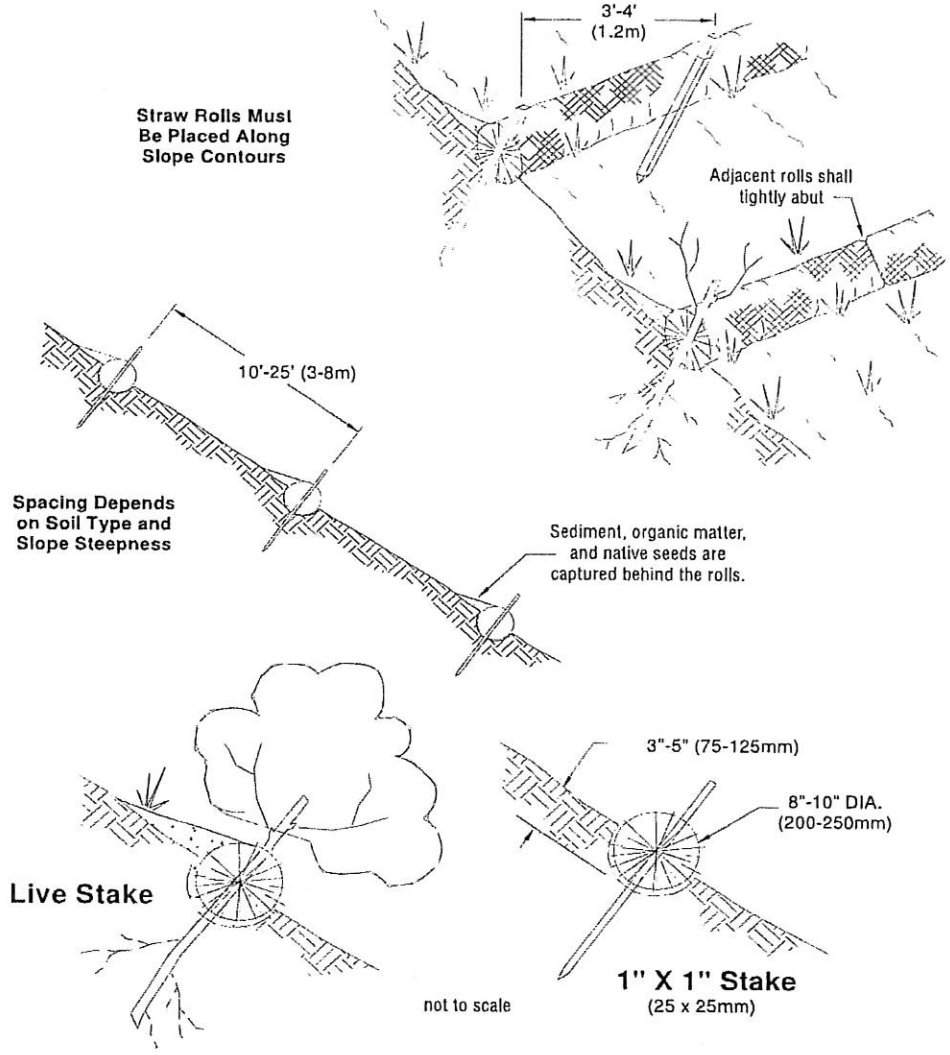
Maintenance Standards

- The spreader should be inspected after every runoff event to ensure that it is functioning correctly.
- The contractor should avoid the placement of any materials on the structure and should prevent construction traffic from crossing the structure.
- If the spreader is damaged by construction traffic, it shall be immediately repaired.

BMP 320: Waddles or Wattles

Purpose

Waddles or wattles are temporary erosion and sediment control barriers consisting of straw or other grain, chipped wood, pulverized rubber bits, or other plant fiber fillers that are wrapped in bio-degradable tubular plastic, geo-textile fabric, or similar encasing material. They reduce the velocity and can spread the flow runoff while capturing and retaining sediment. They are typically 8" to 10" in diameter and 20'-0" to 30'-0" long. The wattles are placed in shallow trenches and staked along the contour of disturbed or newly constructed slopes. See the figure below for typical construction details.



Conditions of Use

- Disturbed areas that require immediate erosion protection.
- Exposed soils during the period of short construction delays, or over winter months.
- On slopes requiring stabilization until permanent vegetation can be established.
- Straw wattles are effective for 1 to 2 seasons.
- If conditions are appropriate, wattles can be staked to the ground using willow cuttings for added re-vegetation.
- Rills and gullies can develop beneath wattles if they are not properly entrenched.
- Water can pass between wattles if not tightly abutted together.

Design and Installation Specifications

- It is critical that wattles are installed perpendicular to the flow direction and parallel to the slope contour.

- Narrow trenches should be dug across the slope on contour to a depth of 3" to 5" on clay soils and soils with gradual slopes. On loose soils; steep slopes; or areas with high rainfall, the trenches should be dug to a depth of 5" to 7", or over 50% of the thickness of the wattle.
- Start building trenches and installing wattles from the base of the slope and work up. Excavated material should be spread evenly along the uphill slope and compacted using hand tamping or other methods.
- Construct trenches at contour intervals of 3'-0" to 30'-0" apart depending on the steepness of the slope, soil type, and rainfall. The steeper the slope the closer together the trenches should be.
- Install the wattles snugly into the trenches and abut tightly end to end. Do not overlap the ends.
- Install stakes at each end of the wattle, and at 4'-0" centers along entire length of wattle.
- If required, install pilot holes for the stakes using a straight bar to drive holes through the wattle and into the soil.
- At a minimum, wooden stakes should be approximately ¾" x ¾" x 24". Willow cuttings or 3/8" rebar can also be used for stakes.

Maintenance Standards

- Stakes should be driven through the middle of the wattle, leaving 2" to 3" of the stake protruding above the wattle.
- Wattles may require maintenance to ensure they are in contact with the ground surface and thoroughly entrenched, especially after significant rainfall on steep, sandy soils.
- Inspect the slope after each significant storm and repair any area where wattles are not tightly abutted together or where water has scoured beneath them.

BMP 321: Check Dams

Purpose

Construction of small dams across a swale or ditch reduces the velocity of concentrated flow and dissipates energy while providing a location for sediment and other items to settle out of the water.

Conditions of Use

Where temporary channels or permanent channels are not yet vegetated; channel lining is unfeasible; and velocity checks are required.

- Check dams may not be placed in permanent- or seasonally-flowing streams unless approved by the U.S. Fish and Wildlife Service (USFWS). Check dams may not be placed in wetlands without approval from all permitting agencies.
- Check dams shall not be placed below the expected backwater from any fish-bearing water between October 1 and May 31 to ensure that there is no loss of high flow refuge habitat for over-wintering juvenile fish.

Design and Installation Specifications

Whatever material is used, the dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the dam rather than falling directly onto the ditch bottom.

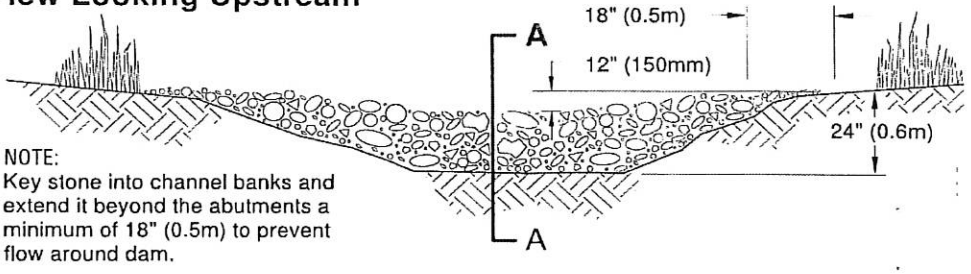
Check dams with sumps work more effectively at slowing flow and retaining sediment than a check dam alone. A deep sump should be provided immediately upstream of the check dam.

- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor re-grading. They may be left as either spillways (accumulated sediment should be graded and seeded), or as check dams to prevent further sediment from leaving the site.
- Check dams can be constructed of rock or pea-gravel filled bags. A number of new products are also available for this purpose and tend to be re-usable, quick and easy to install, effective, and cost

efficient.

- Check dams should be placed perpendicular to the flow of water.
- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
- Keep the maximum height at 24" at the center of the dam.
- Keep the center of the check dam at least 12" lower than the outer edges at natural ground elevation.
- Keep the side slopes of the check dam at 2:1 or flatter. Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18" to avoid washouts from overflow around the dam.
- Use filter fabric under a rock or sand bag check dam. A piece of organic or synthetic blanket cut to fit will also work for this purpose.
- Rock check dams shall be constructed of appropriately-sized rock. The rock must be placed by hand or by mechanical means (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges. The rock used must be large enough to stay in place given the expected design flow through the channel.
- Scour can occur at the outfall toe if not correctly constructed or maintained.
- In the case of grass-lined ditches and swales, all check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale - unless the slope of the swale is above 4%. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- Ensure that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones.
- This figure depicts a typical rock check dam.

View Looking Upstream



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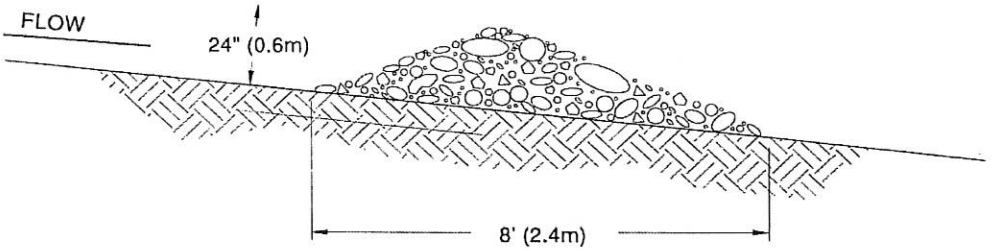
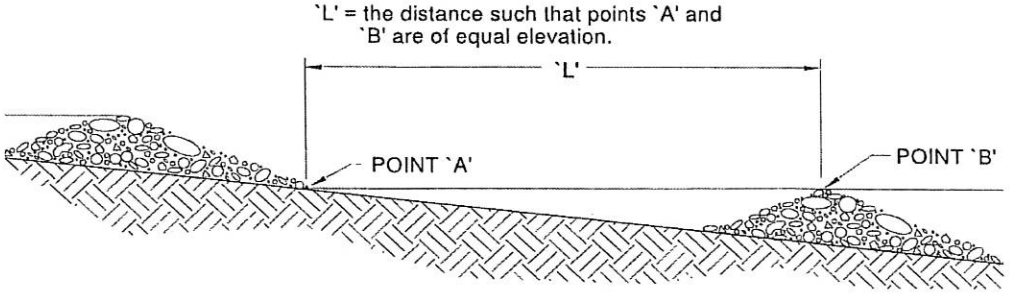


Spacing Between Check Dams



Maintenance Standards

- Check dams shall be inspected weekly and after each runoff event until the upstream area has stabilized. Once stabilization has occur the check dam should be removed unless is to remain as a permanent BMP shown on the plans.
- Permanent dams shall be on stabilized site shall be monitored for performance and sediment accumulation bi-annually and after unusually large storm events to check for stability and needed repairs.
- Sediment shall be removed when it reaches 50% of the sump depth (or height of the dam).
- Inspections should look for missing or dislodged materials. These should be replaced within a timely manner to maintain the dam's shape and function.
- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective stone liner in that portion of the channel.

BMP 322: Geo-Textile Encased Check Dam

Purpose

Geo-Textile Encased Check Dams may be used as for temporary stockpile protection, perimeter protection, inlet protection, or temporary interceptor dike.

Conditions of use

- May be used in place of other typed of temporary check dams in ditches of any dimension.
- May be used on soil or pavement with adhesive or staples.
- Geo-Textile Encased Check Dams have been used to build temporary:
  - diversion ditches
  - sediment ponds
  - concrete wash-out facilities
  - curbing
  - water bars
  - level spreaders
  - berms

Design and Installation Specifications

Generally made of urethane foam sewn into a woven geo-synthetic fabric. It is often triangular, 10" to 14" high in the center, with a 20" to 28" wide base. A 24" wide apron extends beyond both sides of the triangle along its standard length of about 7'-0". A sleeve at one end allows attachment of additional sections as needed.

- Install with ends curved upstream to prevent water from flowing around the ends.
- The fabric flaps and check dam units are attached to the ground with wire staples. Wire staples should be # 11 gage and 8" to 12" long.
- When multiple units are installed, the sleeve of fabric at the end of each unit shall be wrapped over the abutting unit and be stapled into place before the adjoining units are staked to the ground.
- Check dams should be located and installed as soon as construction will allow.
- Check dams should be placed perpendicular to the flow of water. The leading edge must be secured by burying or with rocks, sandbags, or a small key slot and staples.
- When used in grass-lined ditches and swales, check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the

swale is above 4%. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

Maintenance Standards

- Geo-textile Encased Check Dams shall be monitored for performance and sediment accumulation during and after each runoff event.
- Sediment shall be removed when it reaches 50% of the height of the dam.
- Anticipate submergence and deposition above the dam and erosion from high flows around the edges. Immediately repair any damage or any undercutting of the dam.

BMP 323: Brush Barrier

Purpose

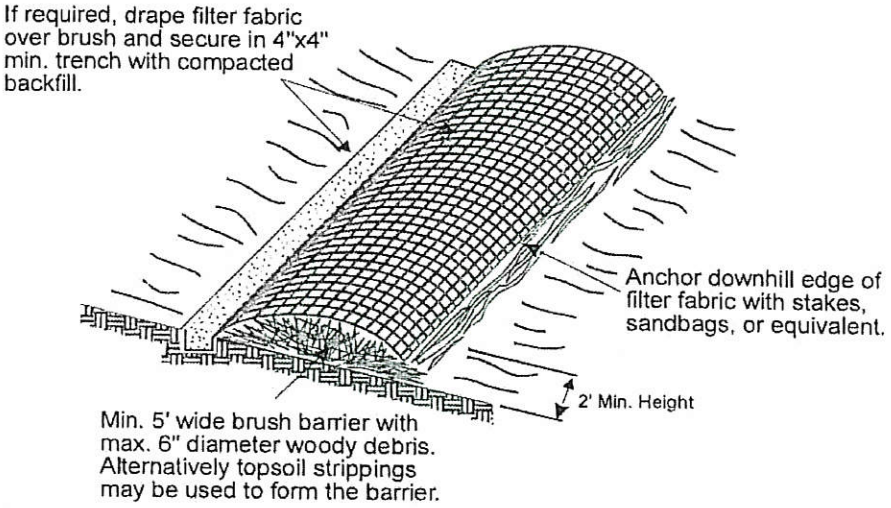
The purpose of brush barriers is to reduce the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

Conditions of Use

- Brush barriers may be used downslope of all disturbed areas of less than 10,000 square feet.
- Brush barriers are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstances in which overland flow can be treated solely by a barrier, rather than a sediment pond, is when the area draining to the barrier is small.
- Brush barriers should only be installed on contours.

Design and Installation Specifications

- Height: 24" (minimum) to 5'-0" (maximum)
- Width: 5'-0" at base (minimum) to 15'-0" (maximum)
- Filter fabric may be anchored over the brush berm to enhance the filtration ability of the barrier. 10-ounce burlap is an adequate alternative for fabric.
- Chipped site vegetation, composted mulch, or wood-based mulch can be used to construct brush barriers.
- There should be no metal, plastic, trash, or other contaminants in the barrier.
- A 100% biodegradable installation can be constructed using 10-ounce burlap held in place by wooden stakes. The figure below depicts a typical brush barrier.



Maintenance Standards

- There shall be no signs of erosion or concentrated runoff under or around the barrier. If concentrated flows are bypassing the barrier, it must be expanded or augmented by toed-in filter fabric.
- The dimensions of the barrier must be maintained.

BMP 324: Gravel Filter Berm

Purpose

A gravel filter berm is constructed on rights-of-way or traffic areas within a construction site to retain sediment by using a filter berm of gravel or crushed rock.

Conditions of Use

Gravel filter berms are used where a temporary measure is needed to retain sediment from entering rights-of-way, in traffic areas, or other paved areas that discharge directly into the drainage system (man-made or natural).

Design and Installation Specifications

- Berm material shall be ¾" to 3" size; washed; well-grade gravel or crushed rock with fewer than 5% fines.
- Spacing of berms:
  Every 300'-0" on slopes flatter than 5%
  Every 200'-0" on slopes between 5% and 10%
  Every 100'-0" on slopes steeper than 10%
- Berm dimensions:
  12" high with 3:1 side slopes
  8'-0" wide per 1.0 cfs runoff, based on the 10-year, 24-hour design storm
  Per local, state, or federal regulations, if more restrictive

Maintenance Standards

Regular inspection is required. Sediment shall be removed and filter material replaced as needed.

BMP 330: Storm Drain Inlet Protection

Purpose

To prevent sediment and other attached pollutants (i.e. oil, grease, trash, debris, herbicides, and pesticides) from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use

Place where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. Protection should be provided for all storm drain inlets and within 500'-0" downslope of a disturbed or construction area, unless the runoff that enters the catch basin will be conveyed to a sediment pond or trap. Inlet protection may be used anywhere to protect the drainage system. It is likely that the drainage system will still require cleaning.

The table below lists several options for inlet protection. All of the methods for storm drain inlet protection are prone to plugging and require a high frequency of maintenance. Drainage areas should be limited to 1 acre or less. Emergency overflows may be required where stormwater ponding would cause a hazard. If

an emergency overflow is provided, additional beyond-the-end-of-pipe treatment will be required.

Table 11: Storm Drain Inlet Protection

Type of Protection	Emergency Overflow	Paved or Earthen Surfaces	Conditions of use
Drop Inlet Protection			
Excavated	Temporary flooding will occur	Earthen	Applicable for heavy flows; easy to maintain; larger drainage area; requires 30'-0" by 30'-0" per drained acre
Block & Gravel	Yes	Paved or earthen	Applicable for heavy concentrated flows; will **NOT** pond
Gravel & Wire	No	----	Applicable for heavy concentrated flows; will pond; can withstand traffic
Basin filters	Yes	Paved or earthen	Frequent maintenance required
Curb Inlet Protection			
Wooden weir	Small capacity overflow	Paved	Used for sturdy, more compact installations
Sediment trap	----	Paved or earthen	18 month expected life
J-Hook	Small capacity overflow	Paved	----

Design and Installation Specifications

No protection should create ponding or flooding on adjoining travel way surfaces, such as streets, driveways, and sidewalks. Where existing curb, gutters, driveways, streets, etc. neighbor an inlet protection device, the device should be no taller than the existing curb height to prevent creating a driving hazard.

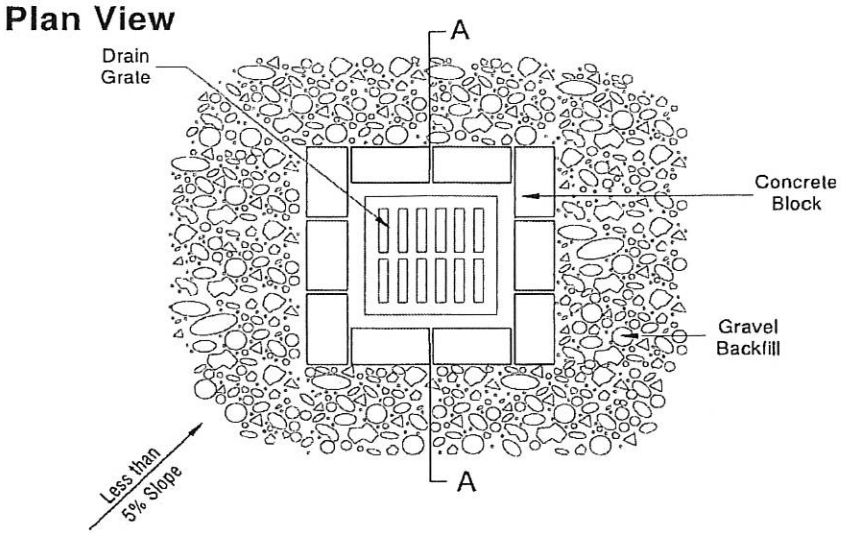
Excavated Drop Inlet Protection is for an excavated impoundment around a storm drain allowing sediment to settle out of the stormwater before it enters a storm drain.

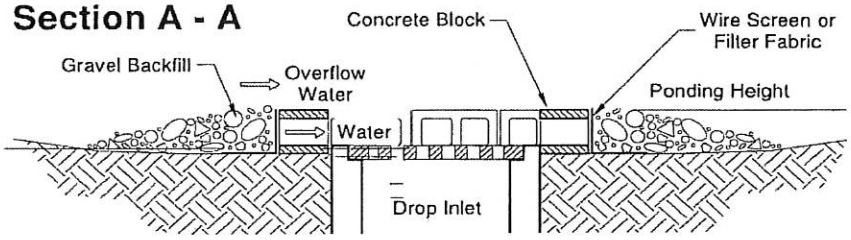
- Depth 12"-24" as measured from the crest of the inlet structure
- Side slopes no steeper than 2:1
- Minimum volume of excavation: 35 cubic yards
- Shape basin to fit site with longest dimension oriented across the longest inflow area
- Install provisions for draining to prevent standing water problems
- Clear the area of all debris
- Grade the approach to the inlet uniformly
- Drill weep holes into the side of the inlet
- Protect weep holes with screen wire and washed aggregate
- Seal weep holes when removing structure and stabilizing area
- It may be necessary to build a temporary dike to the downslope side of the structure to prevent bypass flow.

Block and Gravel Filter is a barrier formed around the storm drain inlet with standard concrete blocks and gravel. See the figure on the top of the next page an example for surface inlets.

- Maximum Height 12" above top of curb
- Recess the first row 2" into the ground for stability
- Support subsequent courses by placing a 2"x4" through the block opening
- Do NOT use mortar. Lay some blocks in the bottom row on their side on either side of the inlet to form a dewatering pool
- Place hardware cloth or comparable wire mesh with ½" openings over all block openings
- Place gravel on the cloth or mesh to an elevation just below the top of blocks and on slopes of 2:1 or flatter. An alternative design is a gravel donut.
- Inlet slope of 3:1
- Outlet slope of 2:1
- 12" wide level stone area between the structure and the inlet

- Inlet slope stones 3" in diameter or larger
- Use ½" to ¾" gravel on outlet slope at a minimum thickness of 12"
- Barrier should allow water to pond - separating sediment from runoff before entering the inlet - but allow all waters to overflow from severe storm events.
- Barriers should be inspected and sediment removed after each storm event. Sediment and gravel must be removed from travel ways immediately.





See the figure on the next page for inlets in the curb line.

Catch-basin Filters are inserts designed by manufacturers for limited sediment storage capacity, so increased inspection and maintenance is required - possibly daily. The maintenance requirements can be reduced by combining a catch-basin filter with another type of inlet protection.

This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way.

- 5 cubic feet of storage
- De-watering provisions
- High-flow bypass that will not clog under normal use at a construction site.
- The catch-basin filter is inserted in the catch-basin just below the grating

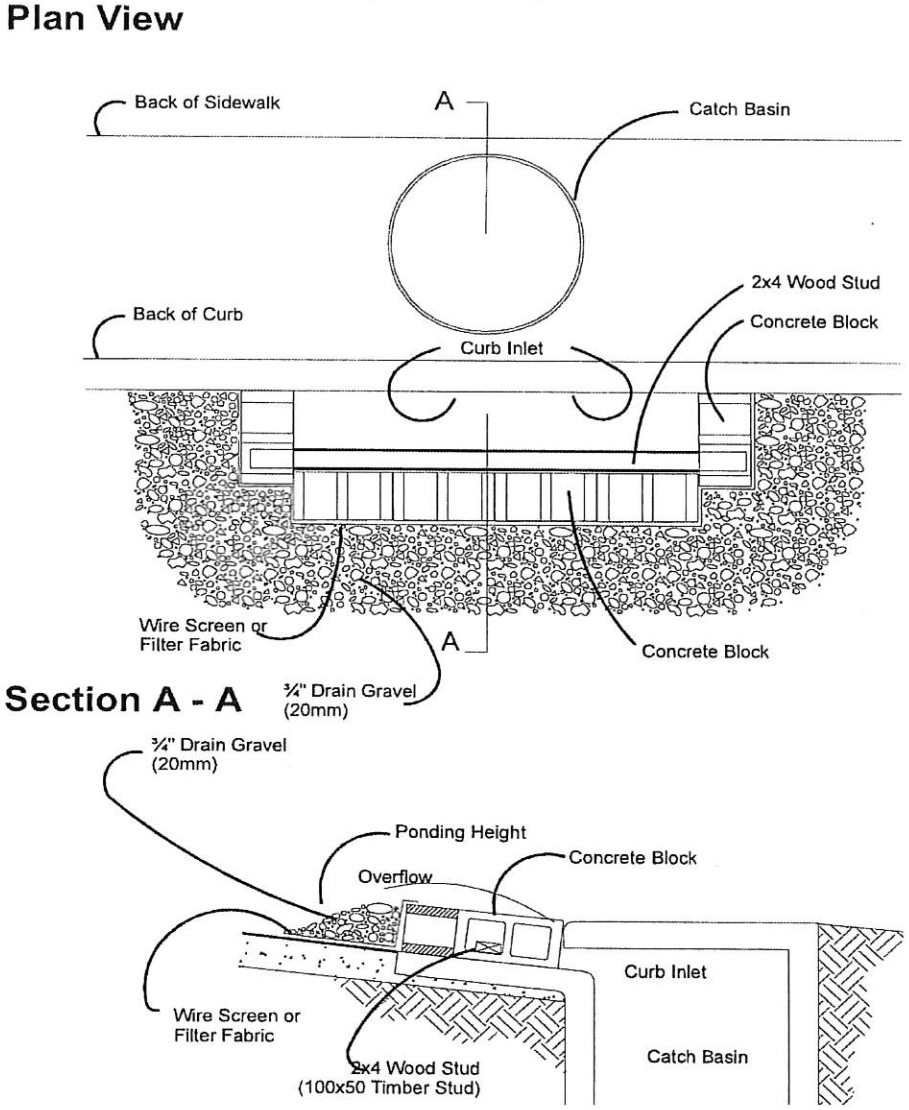
Curb Inlet Protection with Wooden Weir is a barrier formed around a curb inlet with a wooden frame and gravel.

- Wire mesh with ½" openings
- Extra strength filter cloth
- Construct a frame
- Attach the wire and filter fabric to the frame
- Pile coarse washed aggregate against wire/fabric
- Place weight on frame anchors

Curb and Gutter Sediment Trap is usually a sandbag or rock berm filled with pea gravel or other aggregates) 12" high by 3'-0" wide in a horseshoe shape.

- Construct the shaped berm and face with coarse aggregate 3'-0" high by 3'-0" wide, at least 24" from the inlet.
- Construct a sediment trap on the outside of the berm that has been sized to sediment trap standards for protecting a culvert inlet.
- Barrier can be constructed of burlap or woven geo-textile fabric bags filled with gravel. The bags should be layered and packed tightly to form the barrier with a 1-bag-gap in the top row to create an overflow spillway.
- Trap should allow water to pond - separating sediment from runoff before overflowing the barrier and entering the inlet - but should allow all runoff from severe storm events to reach the inlet
- Barriers and traps should be inspected and sediment removed after each storm event. Sediment and

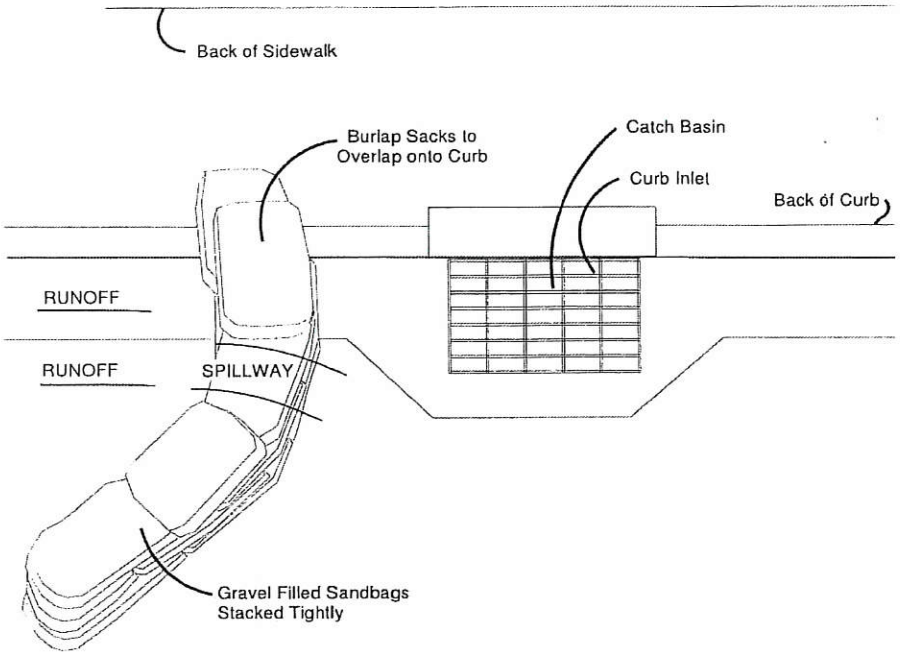
gravel must be removed from travel ways immediately.



See the figure on the next page for a Curb & Gutter Sediment Trap example.

Similar to the Curb & Gutter Sediment Trap is the **J Hook**. This can be made using aggregate-filled bags like the trap above, but also can be easily made using a waddle or wattle (see BMP 321) and forming the fish-hook or J-shape. The leg of the "J" points the runoff into the "bowl" of the hook, which serves as the sediment trap. Once the "bowl" is filled with water, it runs out and enters the inlet. Because the "bowl" is already pulled back from the inlet, removing the sediment can be relatively easy since it has not pushed the wattle into the inlet. The hook can be "reinforced" by placing a section of perforated 4" drain pipe between the "bowl" and the inlet to help keep the wattle from entering the inlet's opening(s). A series of J Hooks can be used to serve as a series of small sedimentation ponds or to catch and filter runoff before entering a street or drainage channel.

Plan View



Maintenance Standards

- Regular maintenance is required to prevent ponding on paved, open-to-the-public, surfaces as well as flooding of adjoining and other nearby facilities and properties.
- Catch basin filters should be inspected frequently, especially after storm events. If the insert becomes clogged, it should be cleaned or replaced.
- For systems using stone filters: If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.

BMP 340: Outlet Protection

Purpose

Outlet protection prevents scour at conveyance outlets; reduces the velocity of concentrated flows; and reduces the energy of concentrated flows - all of which will minimize the potential erosion downstream from the outfall's location.

Conditions of use

Protection is required at all outlets of ponds, pipes, ditches, or other conveyances and where runoff is conveyed to a natural or manmade drainage feature such as a stream, wetland, lake, or ditch.

Design and Installation Specifications

- The receiving channel at the outlet of a culvert shall be protected from erosion for a minimum of 6'-0" downstream and extending up the channel sides a minimum of 12" above the maximum tail-water elevation or 12" above the crown, whichever is higher. For large pipes (larger than 18" in diameter),

the outlet lining of the channel is lengthened to four times the diameter of the culvert. A rock lining or other design element can be used to achieve the same result in an equivalent area (i.e. the length of the apron times the width of the channel bottom).

- Standard wing-walls, and tapered outlets and paved channels should also be considered when appropriate for permanent culvert outlet protection.
- Organic or synthetic erosion blankets are usually more effective than rock, cheaper, and easier to install. Materials can be chosen using manufacturer product specifications. ASTM test results are available for most products and the designer can choose the correct material for the expected flow.
- With low flows, vegetation (including sod) can be effective.
- The following guidelines shall be used for stone outlet protection:
  - If the discharge velocity at the outlet is less than 5 fps and pipe slope is smaller than 1%, use 2" to 8" stone. Minimum thickness is 12".
  - For 5 to 10 fps discharge velocity at the outlet and pipe slope less than 3%, use 24" to 4'-0" stone. Minimum thickness is 24".
  - For outlets at the base of steep slope (or pipe slopes steeper than 10%), an engineered energy dissipater shall be used.
- Filter fabric or erosion control blankets should always be used under the stone to prevent scour and channel erosion.
- New pipe outfalls can provide an opportunity for fish habitat improvements. For example, an alcove of low-velocity water can be created by constructing the pipe outfall and associated energy dissipater back from the stream edge and digging a channel, over-widened to the upstream side, from the outfall. Bank stabilization, bio-engineering, and habitat features may be required for disturbed areas.
- Local drainage and development standards and guidelines shall be reviewed to verify that the materials called for in the plans are acceptable to the regulating jurisdiction.

Maintenance Standards

- Inspect and repair as needed.
- Add rock as needed to maintain the intended function.
- Clean energy dissipater(s) if sediment builds up.
- If stone or rock is used, it should be placed on a geo-textile fabric and inspected at least once every 6 months.
- Dislodged and/or missing quantities shall be replaced in a reasonable and timely fashion.

See BMP 341 for Energy Dissipaters BMPs if this item becomes an on-going maintenance issue.

BMP 341: Energy Dissipaters

Purpose

Swift moving water has large amounts of active energy associated with it that can wear away the soil, particularly by scour.

Conditions of Use

Energy dissipaters need to be placed in locations (such as below outfalls of point discharges that have significantly higher post-development flow rates than the overland sheet flows of pre-developed site conditions) that can prevent erosion of soils by slowing down the speed of the flowing water or by spreading out the area that the water interacts with.

Design and Installation Specifications

Energy can be dissipated through a variety of options. Taller vegetation will generally dissipate more energy than very short vegetation. Vegetation versus pavement will also disperse energy. Energy can also be

released by spreading out the flow instead of sending into a pipe or channel, or even trying to keep it contained in channels once a flow has been "condensed." Reducing the depth of the flow also can reduce the energy of the flow. Unfortunately, if the steepness of the channel is allowed to increase, it will work against the energy dissipation that channel widening or "shallow"-ing attempts to reduce.

Maintenance Standards

Depending on what the device is made of and how much energy it is subjected to, it may need yearly maintenance or replacement. Annual review of its stability, connectivity, and location within the channel should occur.

Scour can develop in very short periods of time; or not appear at all. Bridges along with other under- and over-pass structures are particularly susceptible to scour so need to be reviewed every 2 to 3 years. Once scour begins to appear, reviews may need to be more frequently, unless preventative BMPs are placed into service quickly.

BMP 350: Square Grain Barrier

Purpose

To decrease the velocity of sheet flows and intercept and detain small amounts of sediment from disturbed areas of limited extent, preventing sediment from leaving the site. See the figure on the next page for details on square grain barriers.

Conditions of Use

Below disturbed areas subject to sheet and rill erosion.

- Square grain barriers are among the most used and **least effective BMPs**. The best use of a square grain bale is hand spread on the site.
- Where the size of the drainage area is no greater than ¼ acre per 100'-0" of barrier length; the maximum slope length behind the barrier is 100'-0"; and the maximum slope gradient behind the barrier is 2:1 where effectiveness is required for less than three months.
- **Under no circumstances should square grain barriers be placed or constructed in concentrated flows such as streams, channels, or ditches**. They are not an adequate method of silt control for anything other than sheet or overland flow.
- Square grain barriers should not be used where rock or hard surfaces prevent the full and uniform anchoring of the barrier.

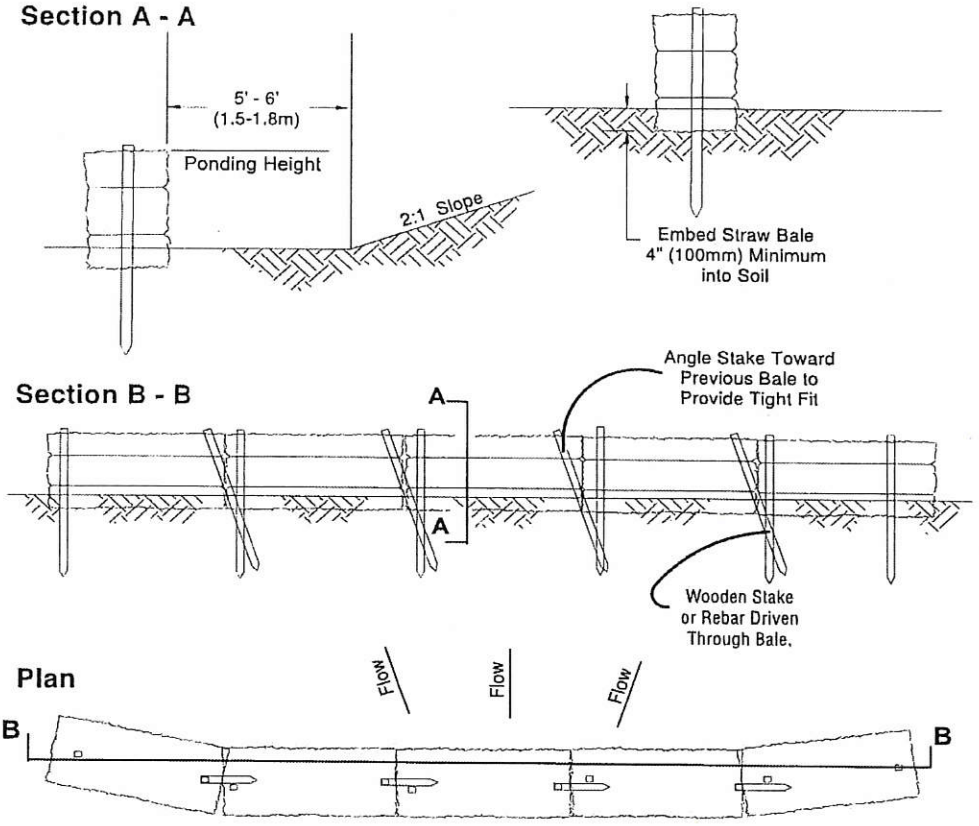
Design and Installation Specifications

Bales shall be placed in a single row, lengthwise **on the contour**, with ends of adjacent bales tightly abutting one another.

- All bales shall be either wire-bound or string-tied. Square grain bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4".
- The trench must be deep enough to remove all grass and other material that might allow underflow. After the bales are staked and chinked (filled by wedging), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and built up to 4" against the uphill side of the barrier.
- Each bale shall be securely anchored by at least 2 stakes or rebar driven through the bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or rebar shall be driven deep enough into the ground to securely anchor the bales.
- Stakes should not extend above the bales but instead should be driven in flush with the top of the

bale for safety reasons.

- The gaps between the bales shall be chinked (filled by wedging) with straw to prevent water from escaping between the bales. Loose straw scattered over the area immediately uphill from a straw bale barrier tends to increase barrier efficiency. Wedging must be done carefully in order not to separate the bales.



Maintenance Standards

- Square grain barriers shall be inspected immediately after each runoff event and at least daily during prolonged rainfall.
- Close attention shall be paid to the repair of damaged bales, end runs, and undercutting beneath bales. Necessary repairs to barriers or replacement of bales shall be accomplished promptly.
- Sediment deposits should be removed after each runoff event.
- Square grain bales must be removed when the level of deposition reaches approximately ½ the height of the barrier.
- Any sediment deposits remaining in place after the Square grain barrier is no longer required shall be dressed to conform to the existing grade, prepared and seeded.
- Square grain bales used as temporary barriers shall be removed after project completion and the site has been stabilized to prevent sprouting of unwanted vegetation.

BMP 351: Embedded Reinforced Perimeter Sediment Barrier

Purpose

Use of an Embedded Reinforced Perimeter Sediment Barrier (ERPSB) reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. The reinforcing is placed behind the barrier supports it as sediment is

captured during a storm event. See the figure below for details on ERPSB construction.

Conditions of Use

- ERPSB may be used downslope of all disturbed areas.
- ERPSBs are not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in where overland flow can be treated solely by an ERPSB, rather than a sediment pond, is when the area draining to the fence is under 39,000 square feet and the flow rates are below 0.5 cfs.
- **Under no circumstances should ERPSBs be placed or constructed in concentrated flows such as streams, channels ditches.** They are not an adequate method of silt control for anything other than sheet or overland flow.
- ERPSB s should run across slopes to capture runoff. Barriers that run up-and-down slopes will collect runoff and concentrate it, which will result in a failure of the fence at any corners at the bottom where the Barrier is then "turned" to run across the slope.

Design and Installation Specifications

- Drainage area of less than 39,000 square feet or in combination with sedimentation basin in a larger site.
- Maximum slope steepness (perpendicular to the fence line): 1:1
- Maximum sheet or overland flow path length to the fence: 100'-0"
- No flows over 0.5 cfs
- The geo-textile used shall meet the standards in the table below. All properties listed are minimum average roll values. (i.e. the test result for any sampled roll in a lot shall meet or exceed the values shown.)

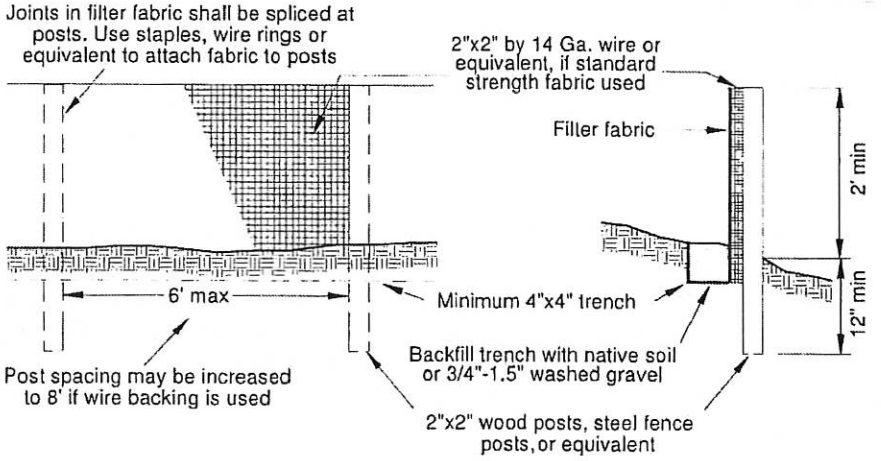


Table 12: Geo-textile Standards for Embedded Reinforced Perimeter Sediment Barriers

Polymeric Mesh AOS (ASTM D4751)	0.15 mm min. for all types (#100 sieve)
	0.60 mm max. for slit-film woven (#30 sieve)
	0.30 mm max. for all other types (#50 sieve)
Water Permittivity (ASTM D4491)	0.02 sec^{-1} minimum
Grab Tensile Strength (ASTM D4632)	100 lbs. min. for standard strength fabric
	180 lbs. min. for extra-strength fabric
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

- Standard strength fabrics shall be supported with woven-wire mesh with maximum 4" by 4" openings, safety fence, or jute mesh to increase the strength of the fabric. Fence materials are available that have synthetic mesh backing attached.

- Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0°F to 120°F.
- 100% biodegradable silt fence is available that is strong and long lasting. All temporary or construction BMPs shall be removed after the project is completed and stabilized.
- Standard Notes for construction plans and specifications follow in Appendix E. Refer to the figure below for standard ERPSB details.

The contractor shall install and maintain temporary barriers at the locations shown in the Plans. The barrier shall be constructed in the areas of clearing, grading, or drainage prior to starting those activities. A fence shall not function beyond the life of the contract, or 6 months - whichever is **SHORTER**. The barrier shall prevent soil carried by runoff water from going beneath, through, or over the top of the fence, but shall allow the water to pass through it.

The minimum height of the top of barrier shall be 24" and the maximum height shall be 30" above the original ground surface. The geo-textile shall be sewn together at the manufacturer, or at an approved location as determined by the Engineer, to form geo-textile lengths as required. All sewn seams shall be located at a support post. Alternatively, 2 sections of silt fence can be overlapped, provided the Contractor can demonstrate, to the satisfaction of the Engineer or local municipality, that the overlap is long enough and that the adjacent fence sections are close enough together to prevent silt-laden water from escaping through the fence at the overlap.

The geo-textile shall be attached on the upslope side of the posts and support system with staples, wire, and in accordance with the manufacturer's recommendations. The geo-textile shall be attached to the posts in a manner that reduces the potential for geo-textile tearing at the staples, wire, or other connection devices. Barrier back-up support for the geo-textile is dependent on the properties of the geo-textile selected for use. If wire or plastic back-up mesh is used, it shall be fastened securely to the upslope of the posts with the geo-textile being upslope of the support.

The geo-textile at the bottom of the fence shall be buried in a trench to a minimum depth of 8" below the ground surface on the **upstream** side of the fence posts. The trench shall be backfilled and the soil tamped in place over the buried portion of the geo-textile, such that no flow can pass beneath the fence and scouring can not occur. The wire or mesh support shall also extend into the trench a minimum of 4".

The fence posts shall be placed or driven a minimum of 18". A minimum depth of 12" is allowed if a minimum depth of 18" cannot be reached. Fence post depths shall be increased by 6" if the fence is located on slopes of 3:1 or steeper. The slope must be perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading. As all alternative, the spacing of the posts can be reduced to provide additional support to the fence.

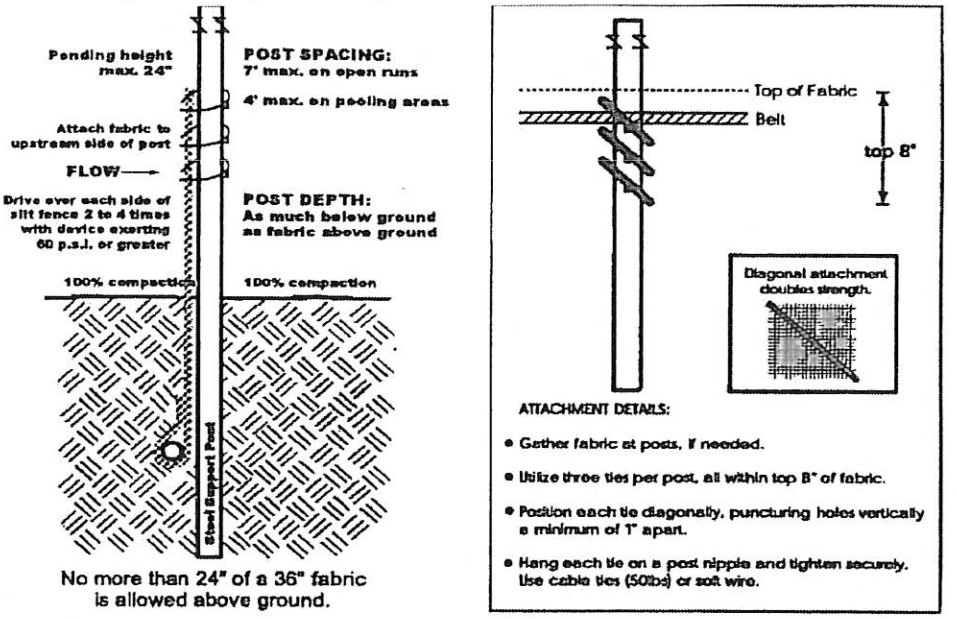
ERPSBs shall be located on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence. If the fence must cross contours, with the exception of the ends of the fence, gravel check dams placed perpendicular to the back of the fence shall be used to minimize concentrated flow and erosion along the back of the fence. The gravel check dams shall be approximately 12" deep at the back of the fence. It shall be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence.

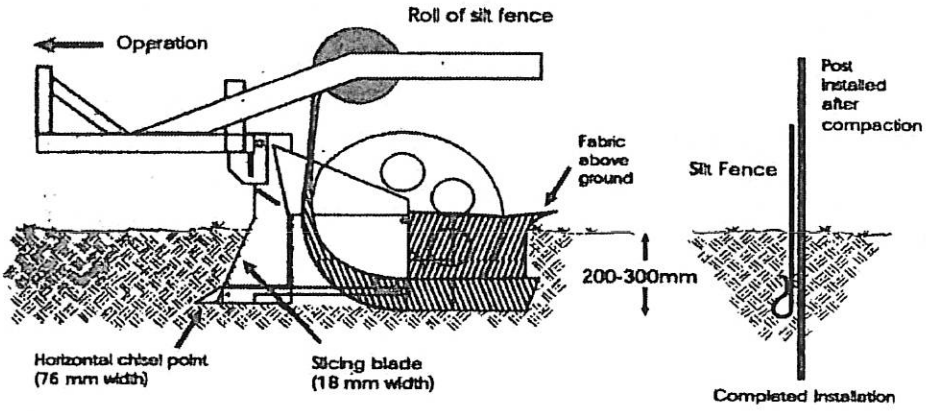
The gravel check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. The gravel check dams shall be located every 10'-0" along the fence where the fence must cross contours. The slope of the fence line where contours must be crossed shall not be steeper than 3:1.

Wood, steel or equivalent posts shall be used. Wood posts shall have minimum dimensions of 2" by 2" by 36" minimum length, and shall be free of defects such as knots, splits, or gouges. Steel posts shall consist of either size ¾ rebar or larger; ASTM A120 steel pipe with a minimum diameter of 1-inch; U-, T-, L-, or C-shape steel posts with a minimum weight of 1.35 lbs./ft. or other steel posts having equivalent strength and bending resistance to the post sizes listed.

The spacing of the support posts shall be a maximum of 6'-0". Wire-back support shall consist of woven (not welded) steel wire with a maximum mesh spacing of 4", or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be more than180 lbs. grab tensile strength. The polymeric mesh must

be as resistant to ultraviolet radiation as the geo-textile it supports.
ERPSB installation using the slicing method specification details follows in the figure below.





Vibratory plow is not acceptable because of horizontal compaction

1. The base of posts must be at least 2" to 4" above the top of the geo-textile fabric on the middle posts for ditch checks to drain properly. Use a string level to mark base points before installation.
2. Install posts 3'-0" to 4'-0" feet apart in critical retention areas and 5'-0" to 6'-0" feet apart in standard applications.
3. Install posts 24" deep on the downstream side of the barrier, and as close as possible to the fabric, enabling posts to support the fabric from upstream water pressure. The top of all posts should be at the top of the silt fence for the prevention of injuries due to falls onto the fence.
4. Attach the fabric to each post with 3 ties within the top 8" of the fabric. Attach each tie diagonally 45-degrees through the fabric, with each puncture at least 1" vertically apart. In addition, each tie should be positioned to hang on a post nipple to prevent sagging.
5. Wrap approximately 6" of fabric around the end posts and secure with 3 ties.
6. No more than 24" of a 36" fabric is allowed above ground level.
7. The rope lock system must be used in all ditch check applications.
8. The installation should be checked and corrected before compaction. Use a flat-bladed shovel to tuck fabric deeper into the ground if necessary.
9. Compaction is vitally important for effective results. Compact the soil immediately next to the fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 psi. Compact the upstream side first and then the downstream side. Repeat each side twice for a total of 4 trips.

Maintenance Standards

- Inspection is required at least after every rain event until the site above the BMP is stabilized to regulating standards. Inspections preferably would occur immediately **prior** to each predicted runoff events to make sure the barrier will in working conditions when the events happen.
- All damages shall be repaired immediately.
- If concentrated flows are evident uphill of the fence, they must be intercepted and conveyed to a sediment pond.
- It is important to check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow - resulting in channelization of flows parallel to the fence. If this occurs, replace the fence and remove all trapped sediment.
- Sediment deposits shall either be removed when the deposit reaches approximately 25% of the height of the ERPSB. A second barrier or sediment "catcher" shall be installed during the removal of the deposited materials from the first fence if the materials being removed, the ground, or the weather is damp and/or wet.
- If the geo-textile has deteriorated due to ultraviolet breakdown, it shall be replaced.
- All barriers shall be replaced at least once every 6 months on projects with longer construction lives.
- Once the site is stabilized, the barrier needs to be removed prior to filing a NOT with the local overseeing jurisdiction.